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Nutrients in the San Joaquin River, California: Trends and Sources

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U.S. Department of the Interior
U.S. Geological Survey

Issues Associated with Nutrients in the San Joaquin River

- **CALFED Drinking Water Issue – algae produced in SJR affects the cost and effectiveness of water treatment**
- **TMDL Issue on Low Dissolved Oxygen in Stockton Ship Channel – algae produced in SJR contribute to dissolved oxygen depletion in ship channel downstream; this can be a barrier to Chinook salmon migration into San Joaquin system**

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Outline

- Description of Study Area
- Long-term Trends in Nutrient Loads and Concentrations
- Long-term Trends in Nitrate Sources
- Nitrate Concentrations and Loads, 2000-01
- Isotopic Analysis of Nitrate Sources, 2000-01
- Proposed Study of Nitrate Inputs from Groundwater and their Source

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Description of Study Area

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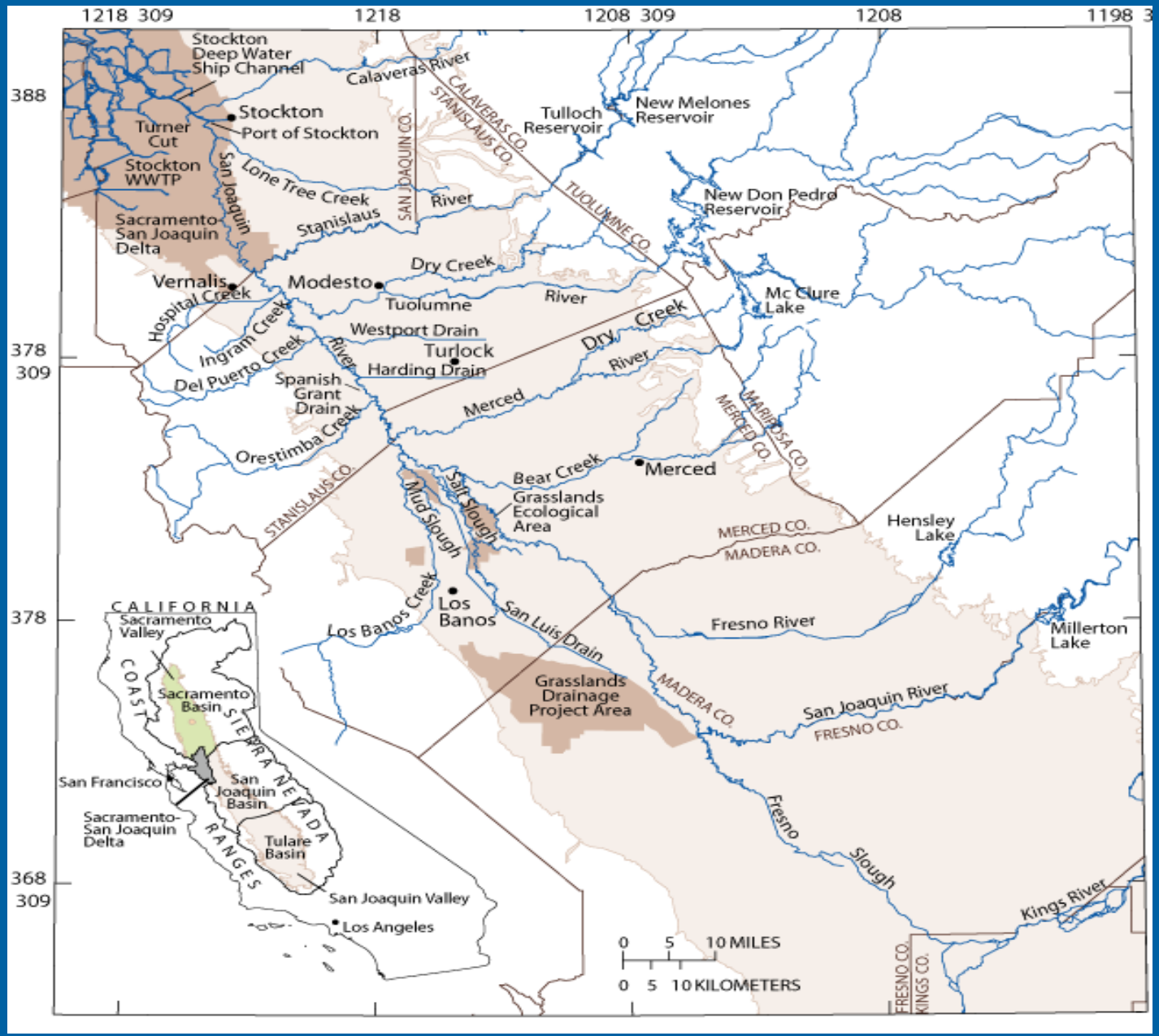
Study Area



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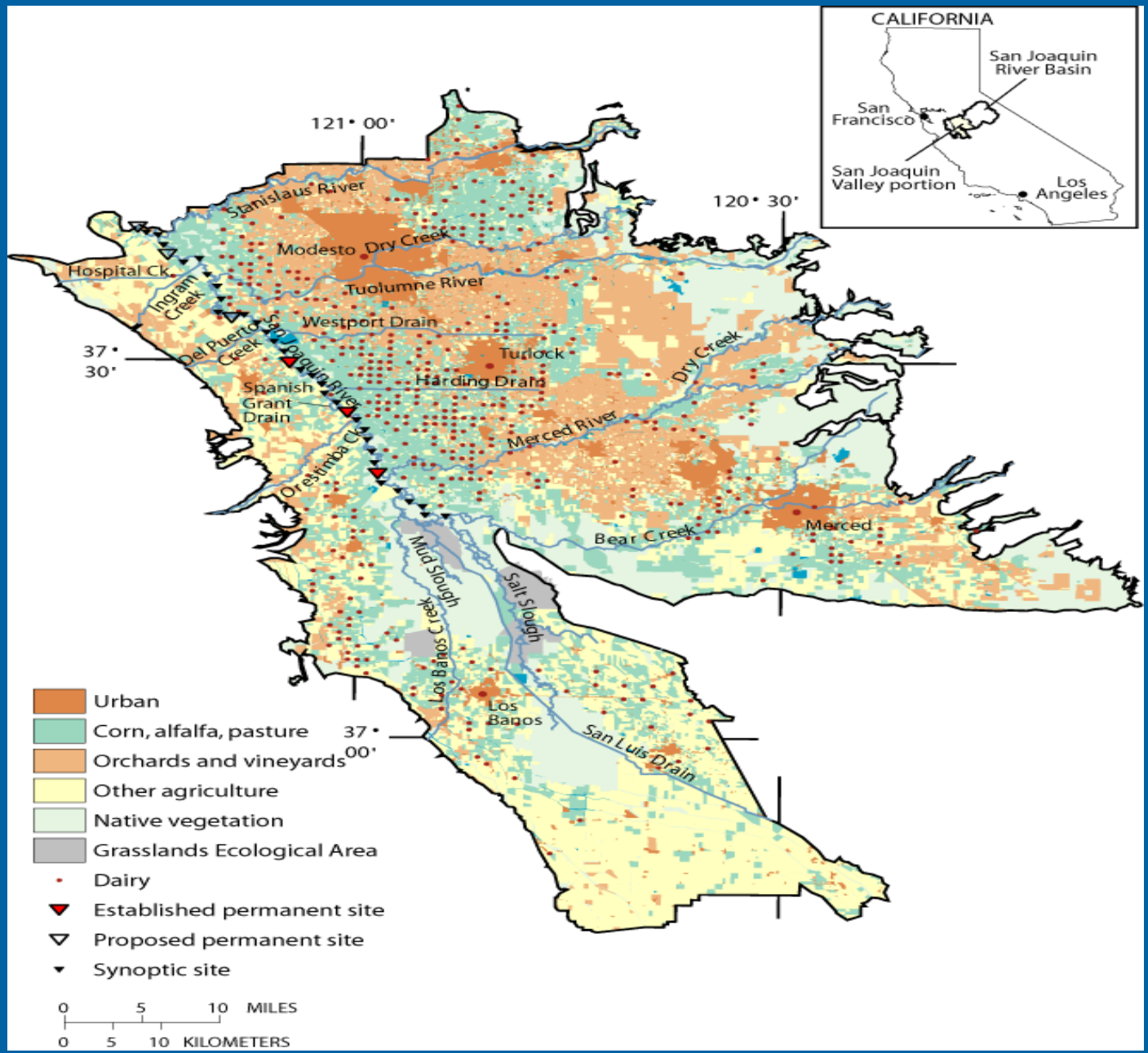
Land Use



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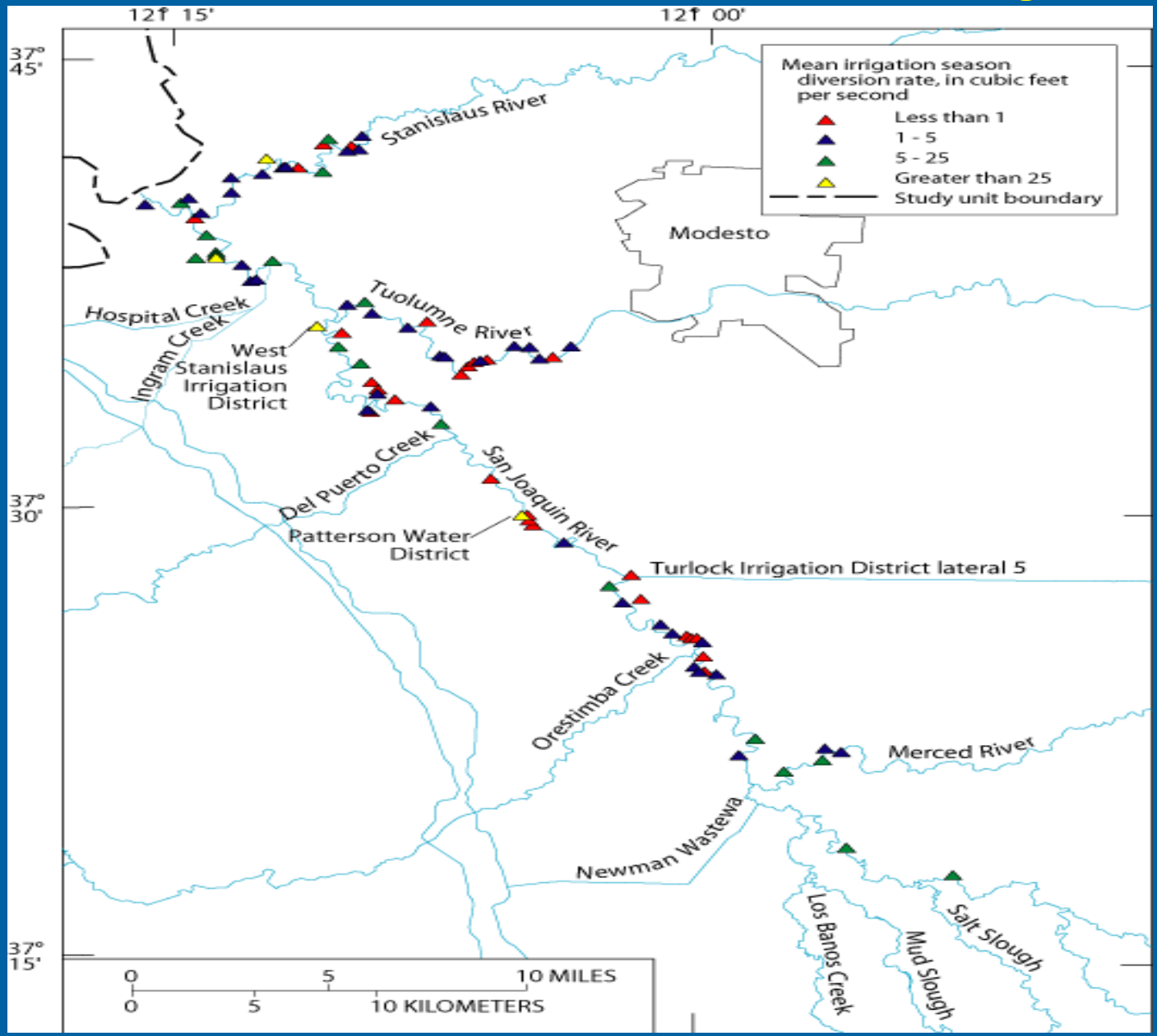
Agricultural Diversions from SJR System



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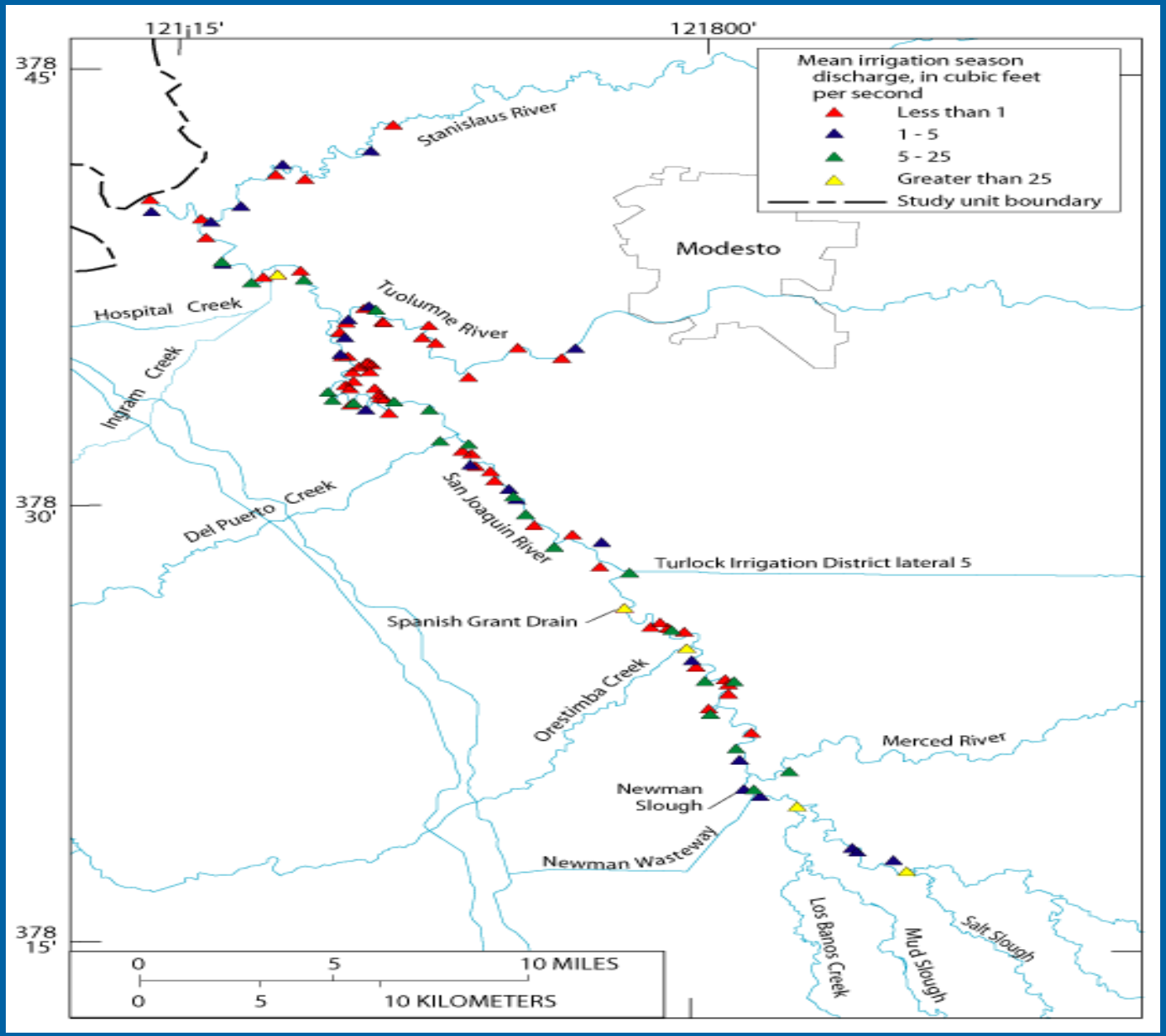
Agricultural Discharges to SJR System



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Long-term Trends in Nutrient Loads and Concentrations

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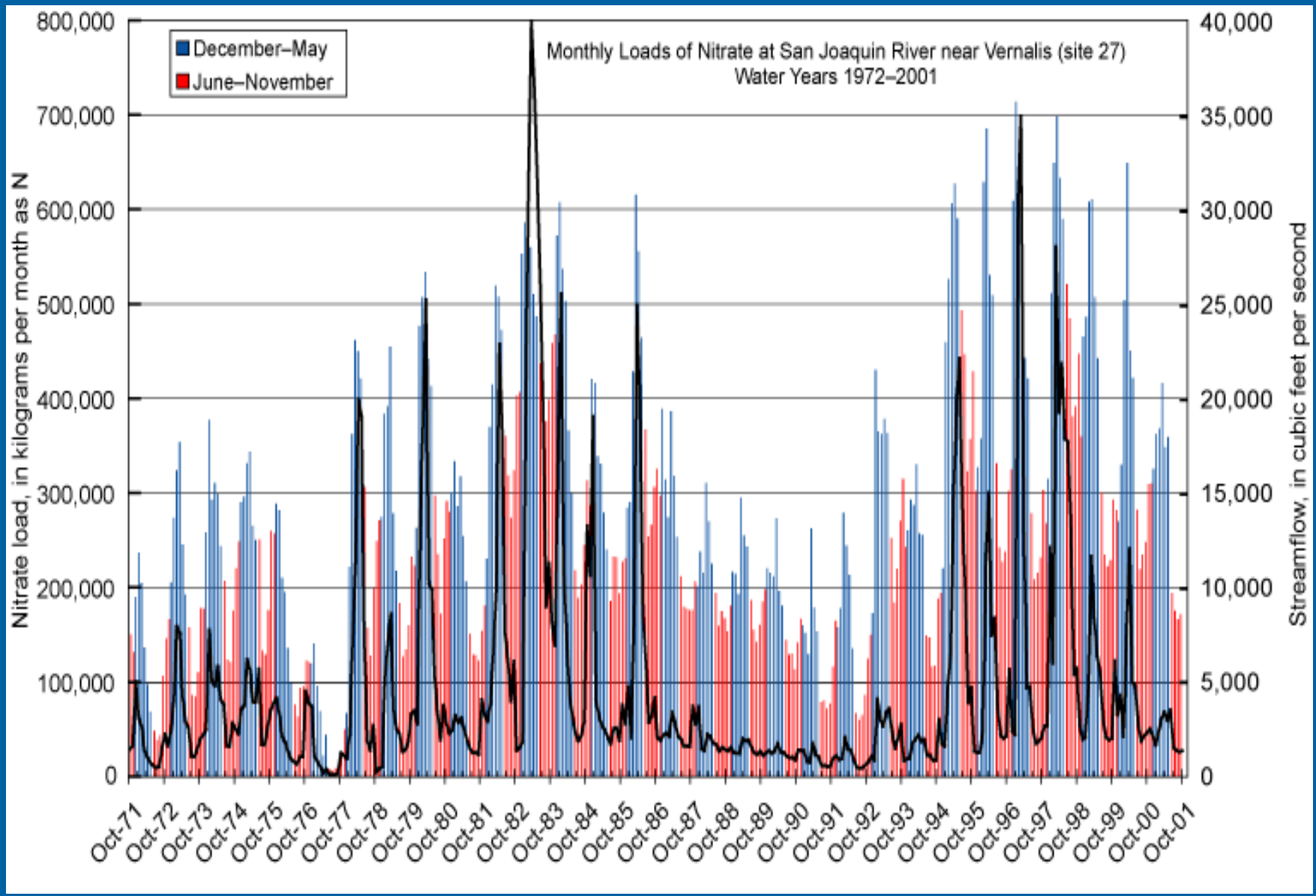
Nitrate Loads (1972-2001)



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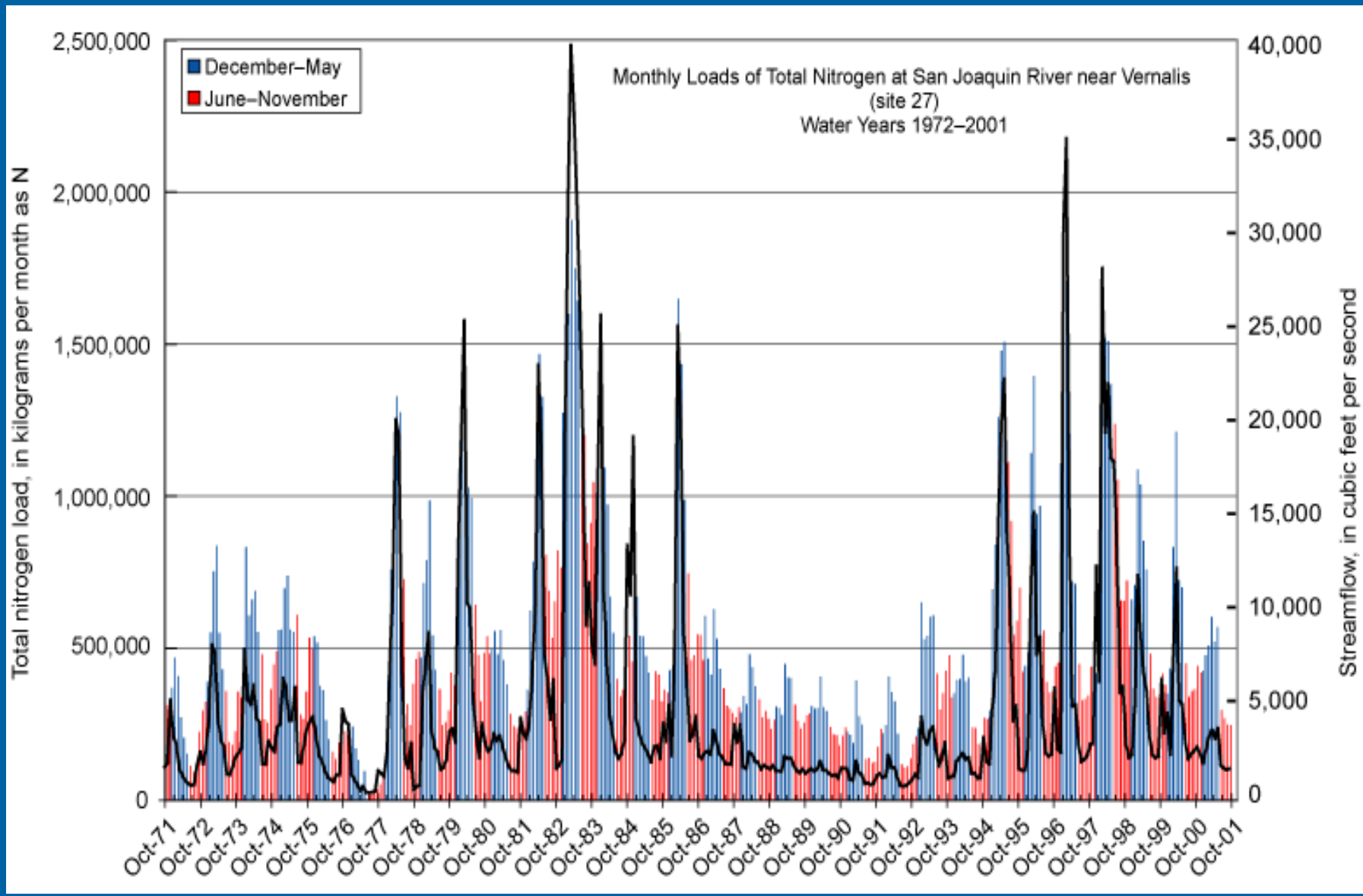
Total Nitrogen Loads (1972-2001)



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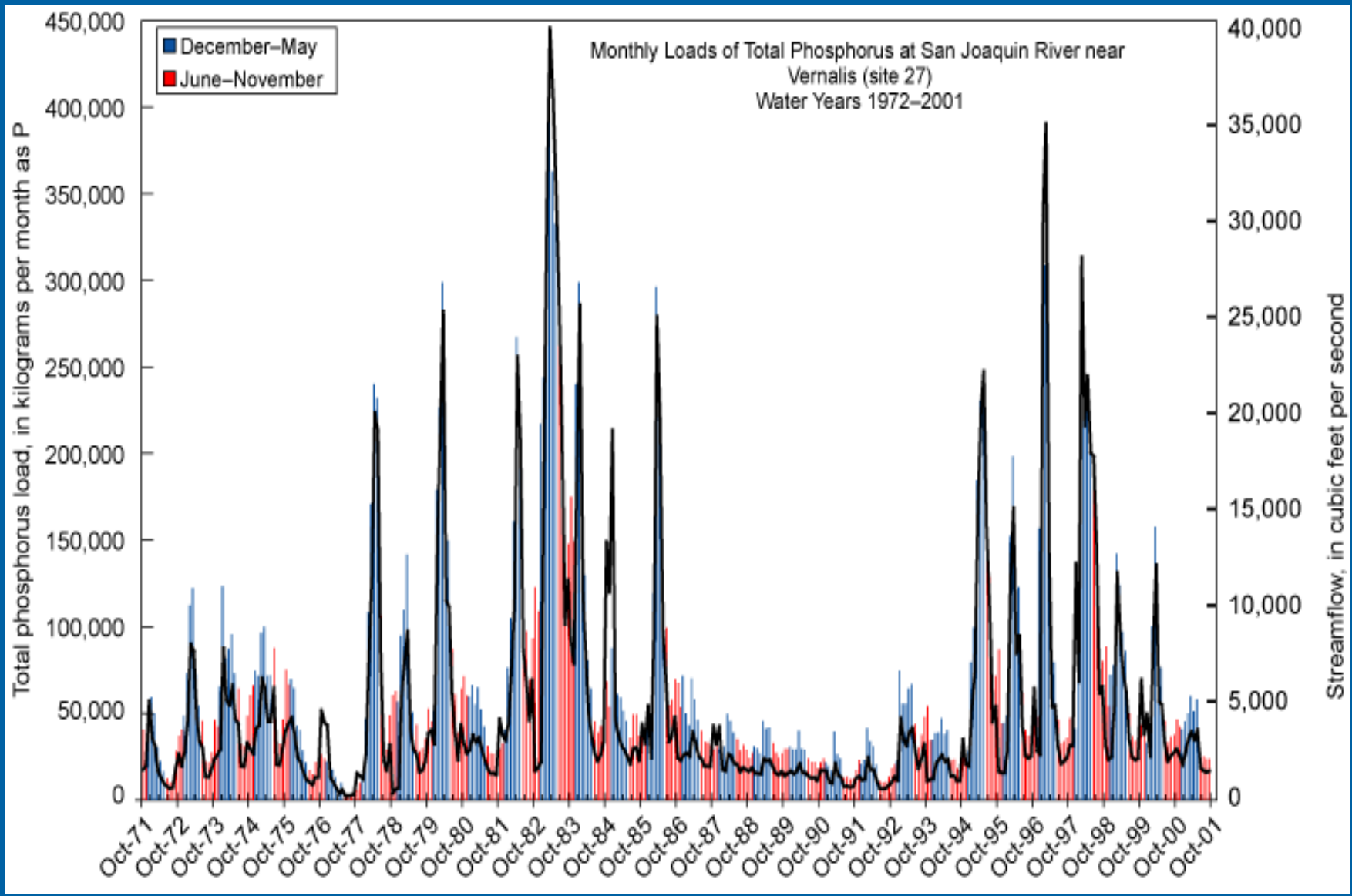
Total Phosphorus Loads (1972-2001)



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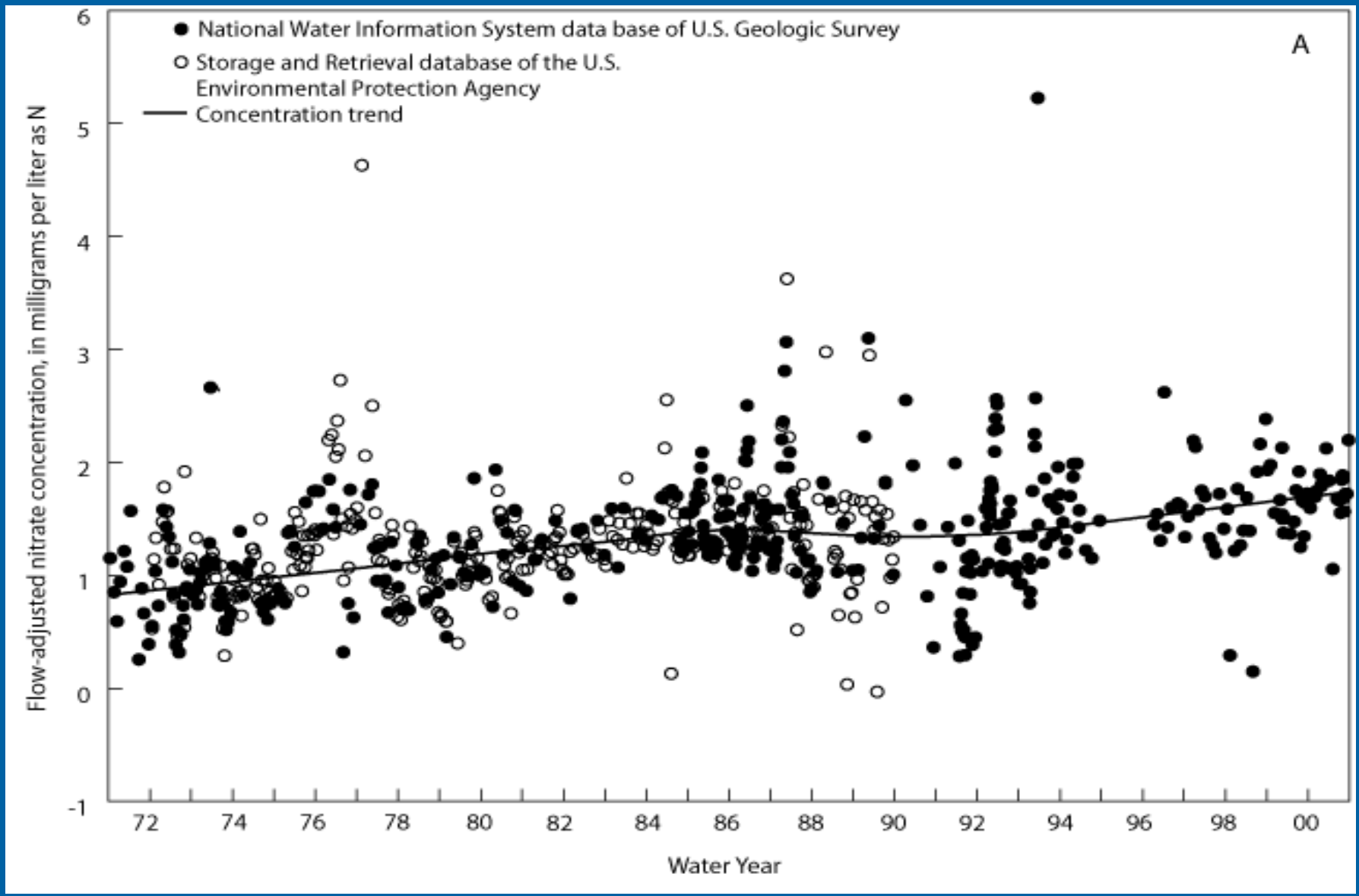
Flow-adjusted Nitrate Trend (1972-2001)



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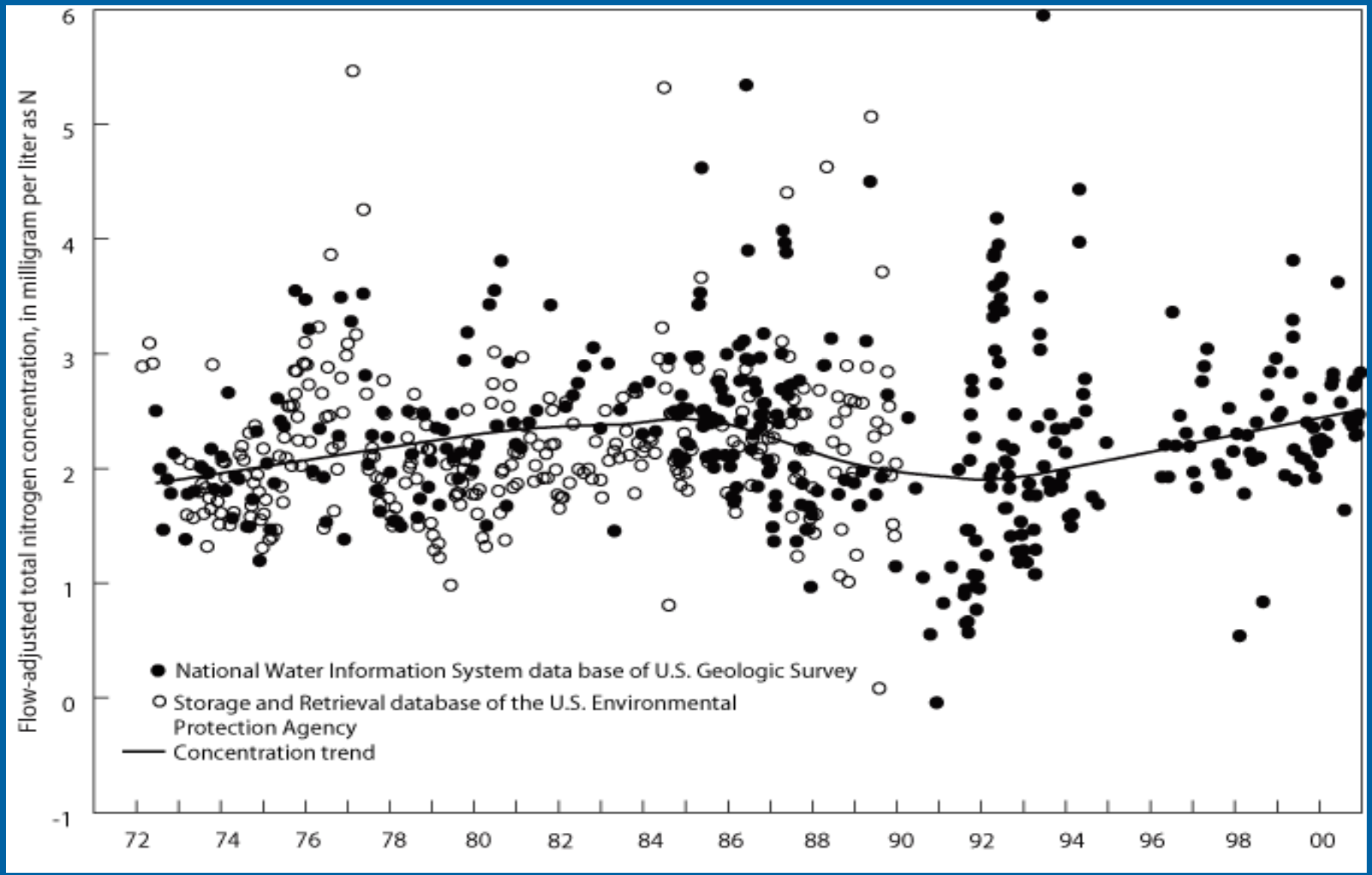
Flow-adjusted Total Nitrogen Trend (1972-2001)



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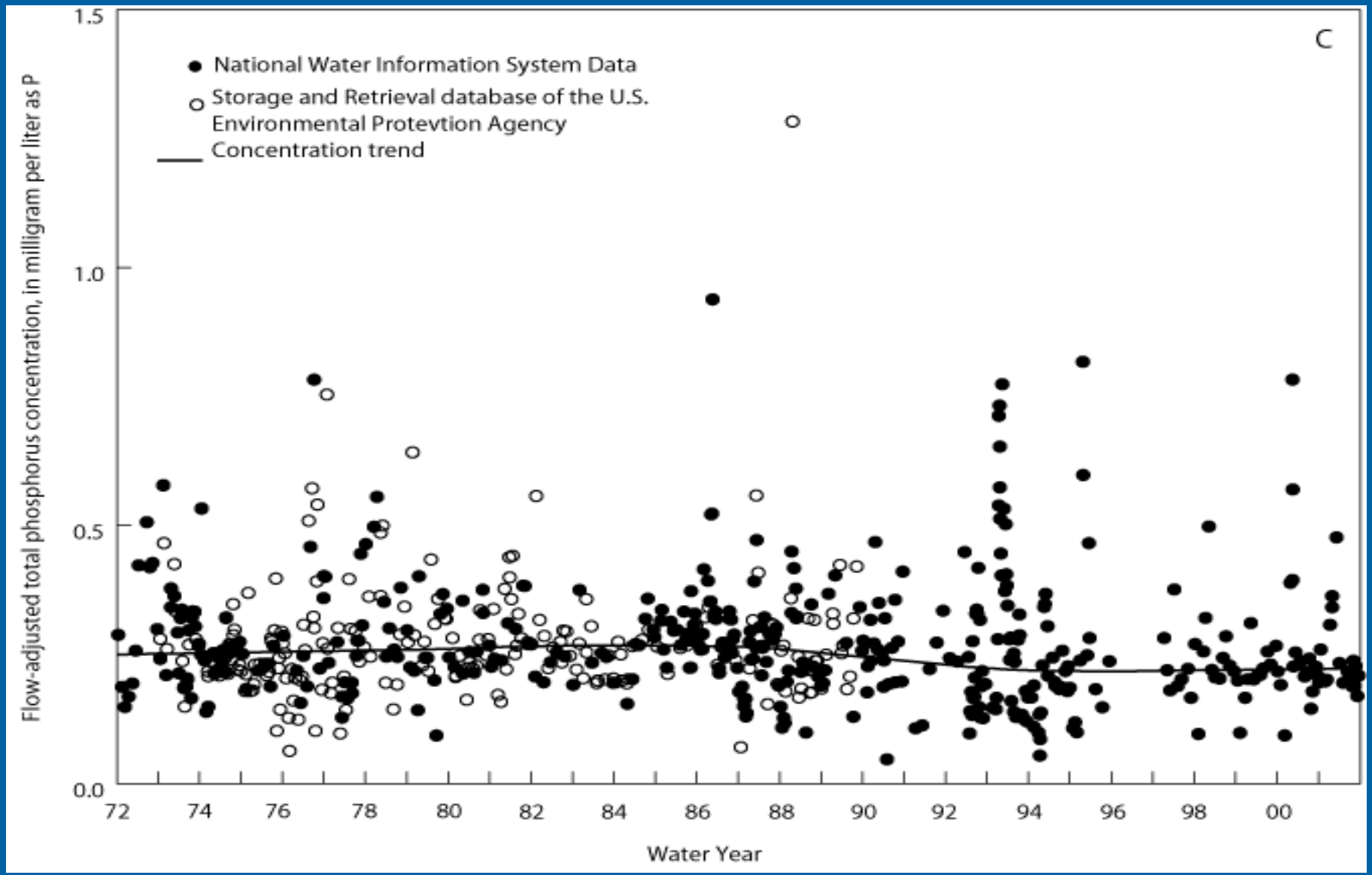
Flow-adjusted Total Phosphorus Trend (1972-2001)



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Long-term Trends in Nitrate Sources

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Nitrate Sources

- Tile Drainage
- WWTPs
- Fertilizer Application
- Manure Production
- Groundwater

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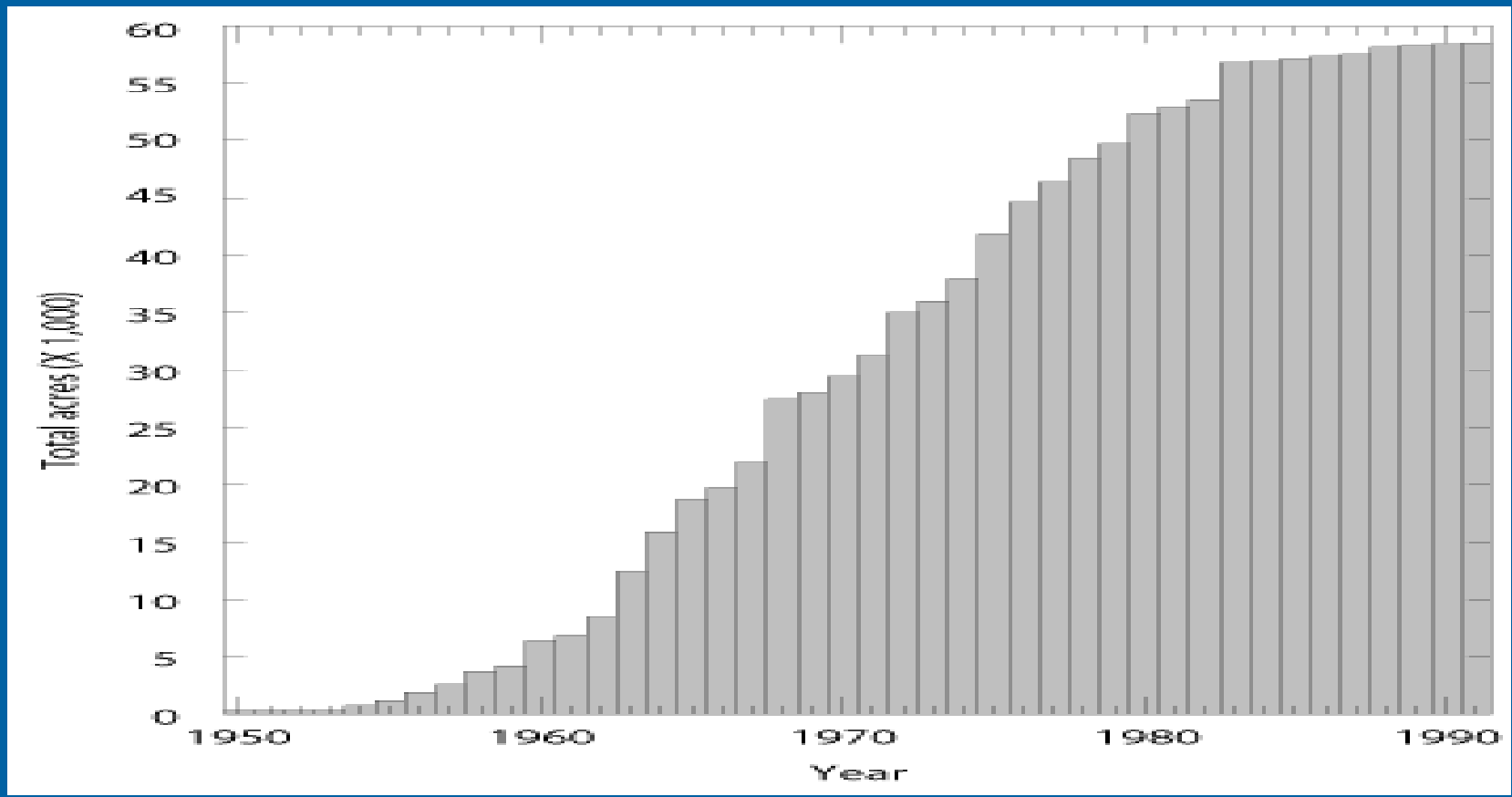
Nitrate Sources: Tile Drainage

Tile-drained Acreage in SJB, 1950-91

[tile-drainage discharge to SJR: 0 cfs in 1950; 47 cfs in 1970; 66 cfs in 1990]



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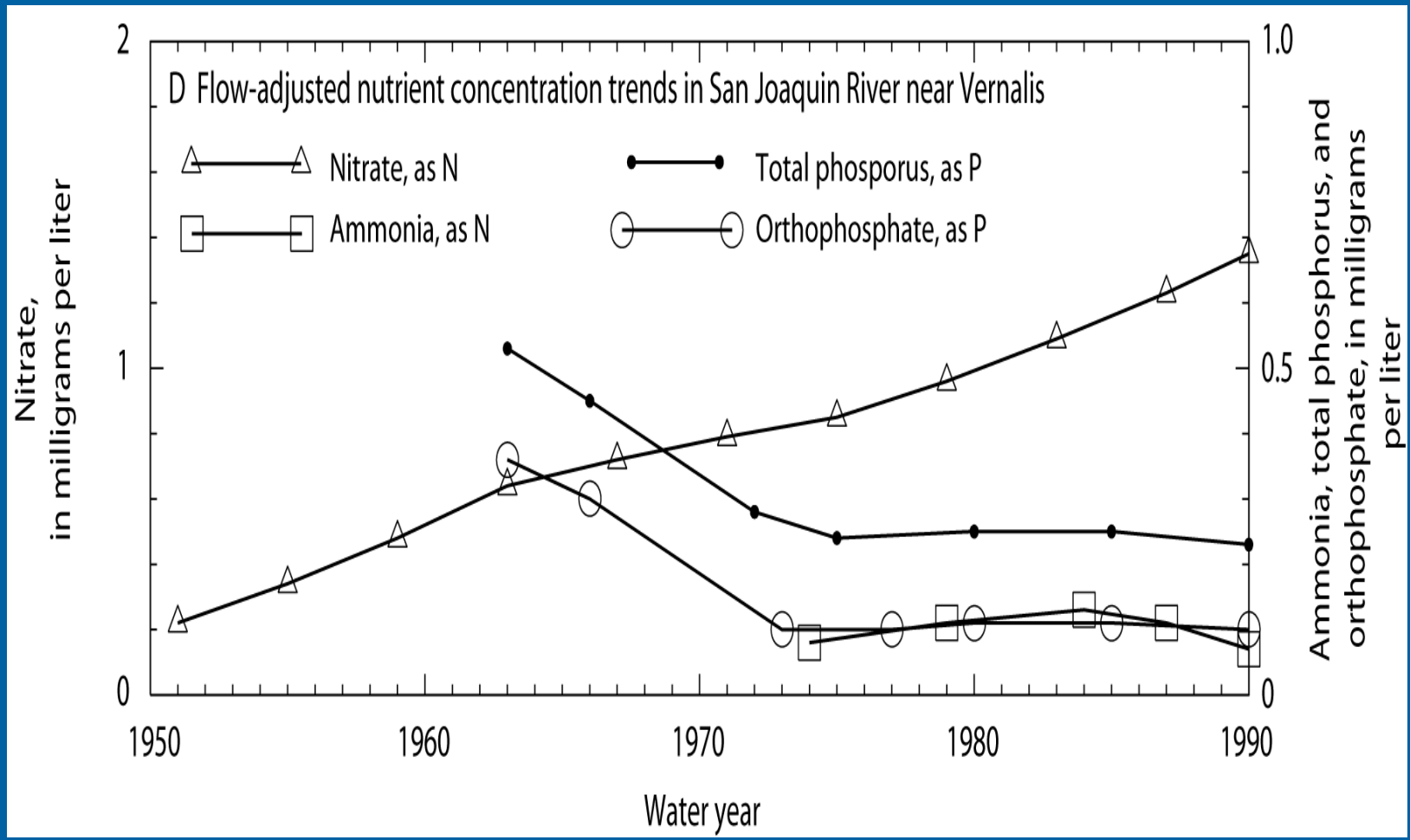
Nitrate Sources: WWTPs

Phosphorus and Ammonia Trends in SJR, 1963-90
[WWTP discharges: 16 cfs in 1950; 43 cfs in 1970; 58 cfs in 1990]



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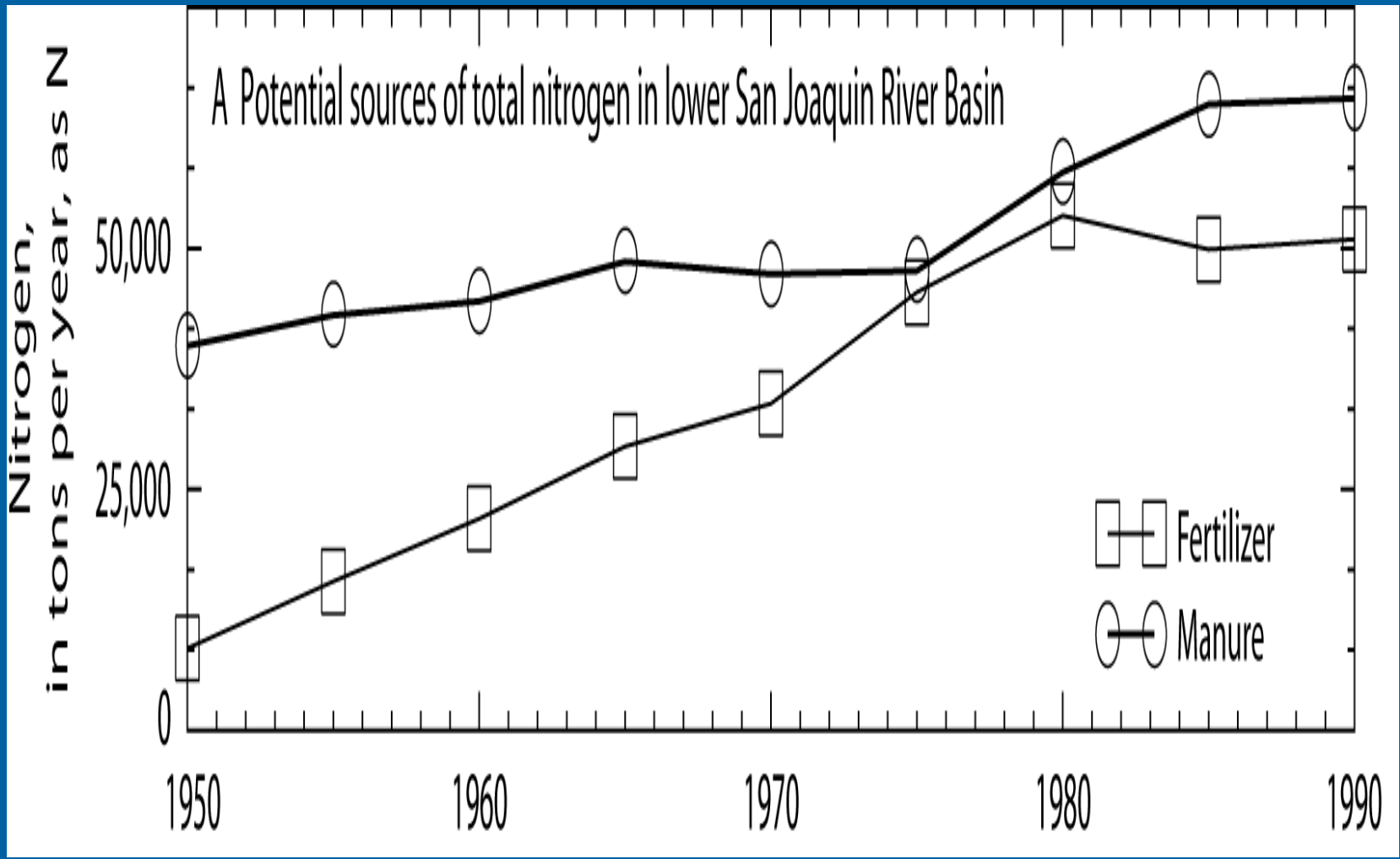
Nitrate Sources: Fertilizer Application and Manure Production



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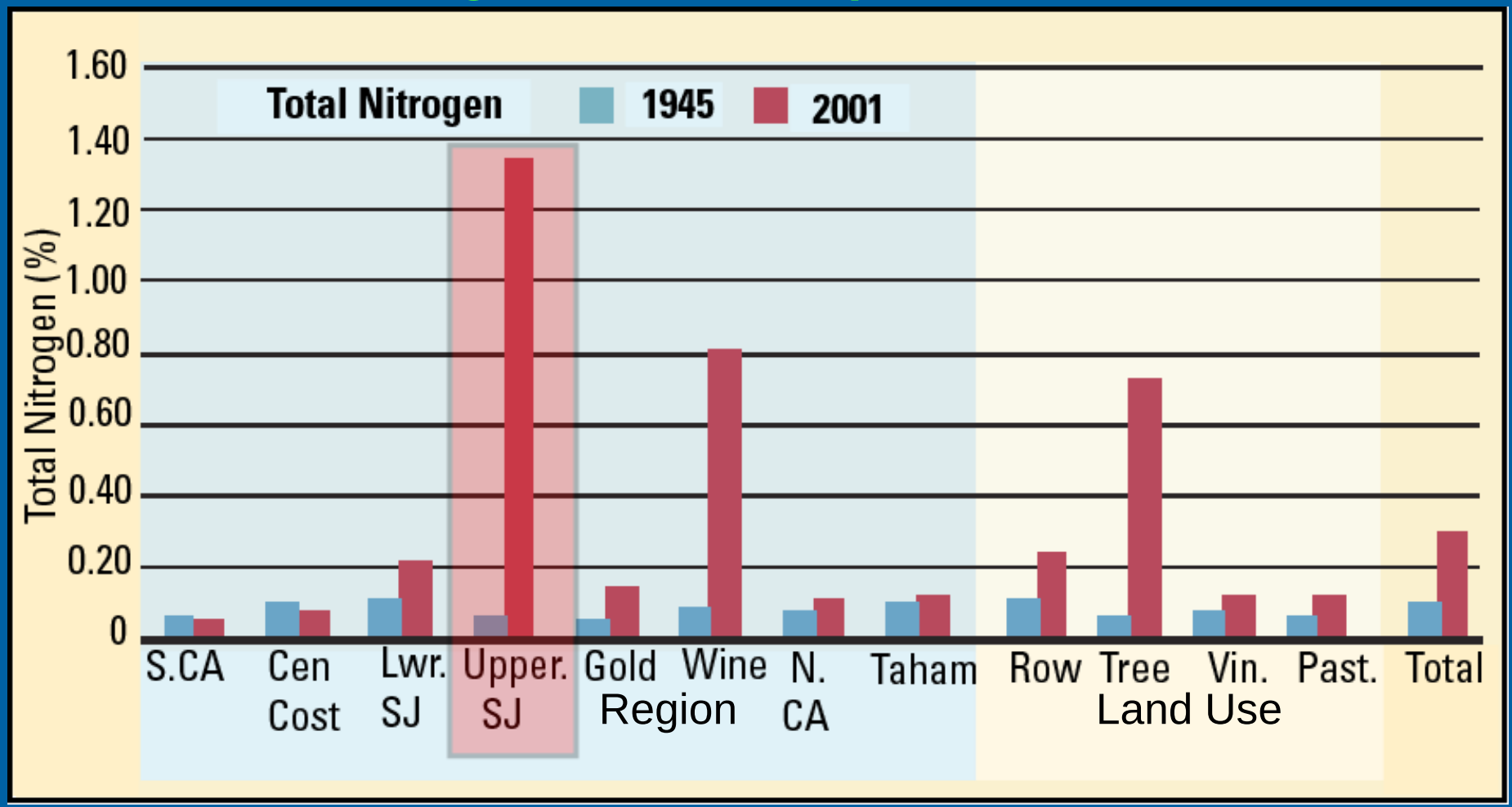
Nitrate Sources: Fertilizer Application and Manure Production

Total Nitrogen in Soil Samples, 1945 and 2001



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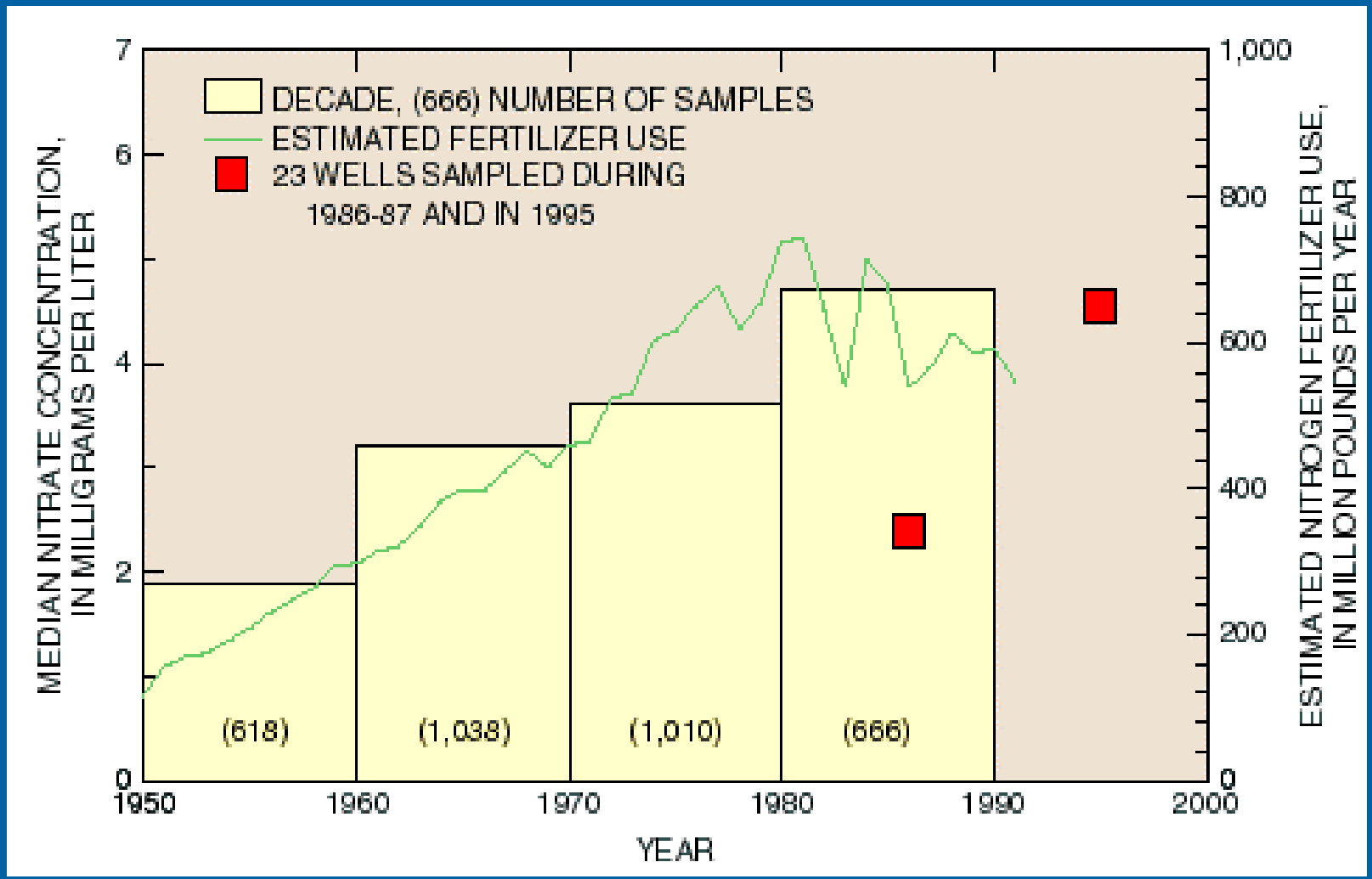
Nitrate Sources: Groundwater

Concentrations in Eastern SJV, 1950s to 1990s



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Nitrate Sources: Summary of Trends

- Tile Drainage – increased in 60's and 70's
- WWTPs – no apparent increase
- Fertilizer Application – increased in 50's, 60's, and 70's
- Manure Production – increased over entire 50 years
- Groundwater – increased over entire 50 years

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Nitrate Concentrations and Loads, 2000-01

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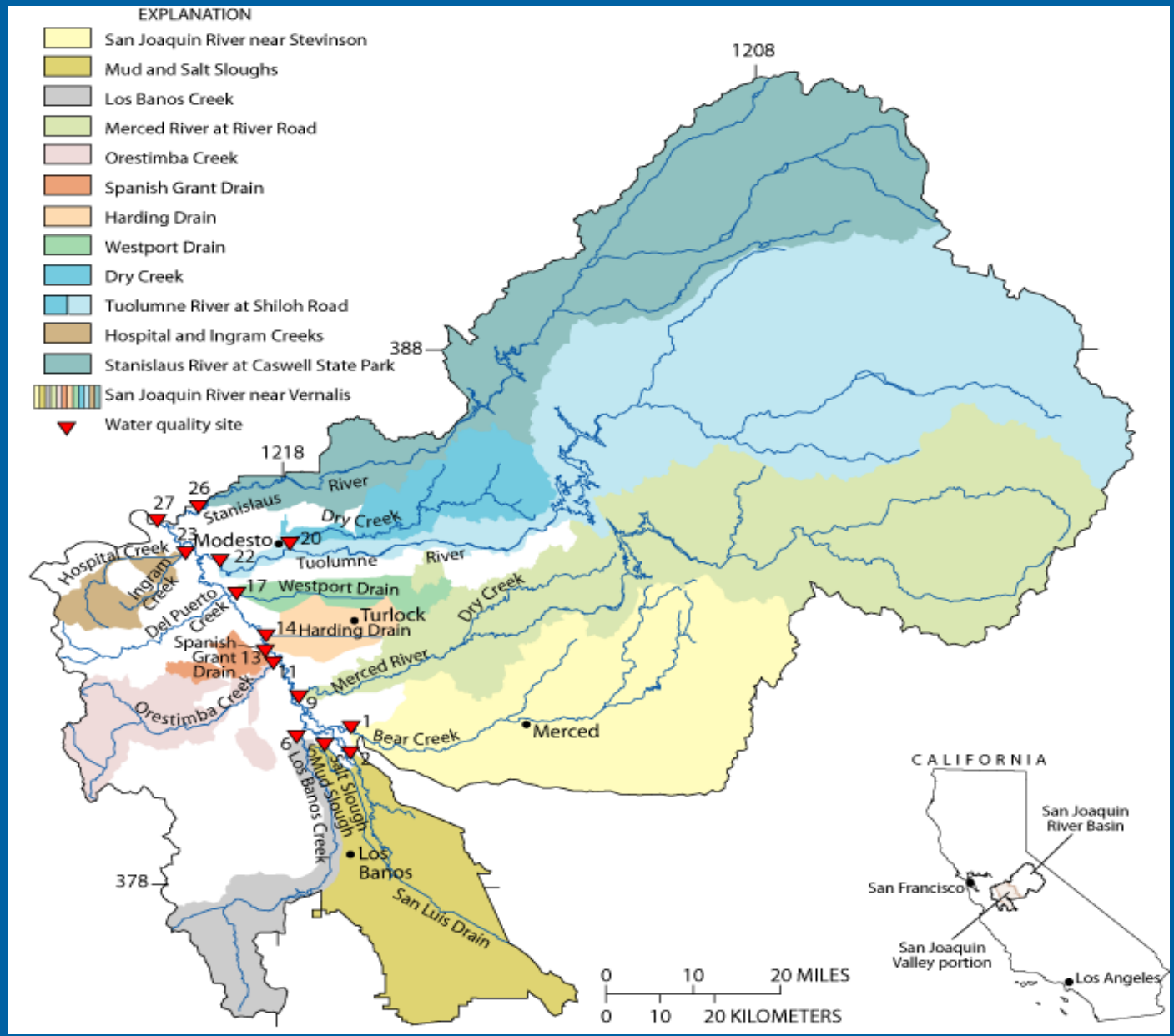
Sites and Basins Sampled (2000-01)



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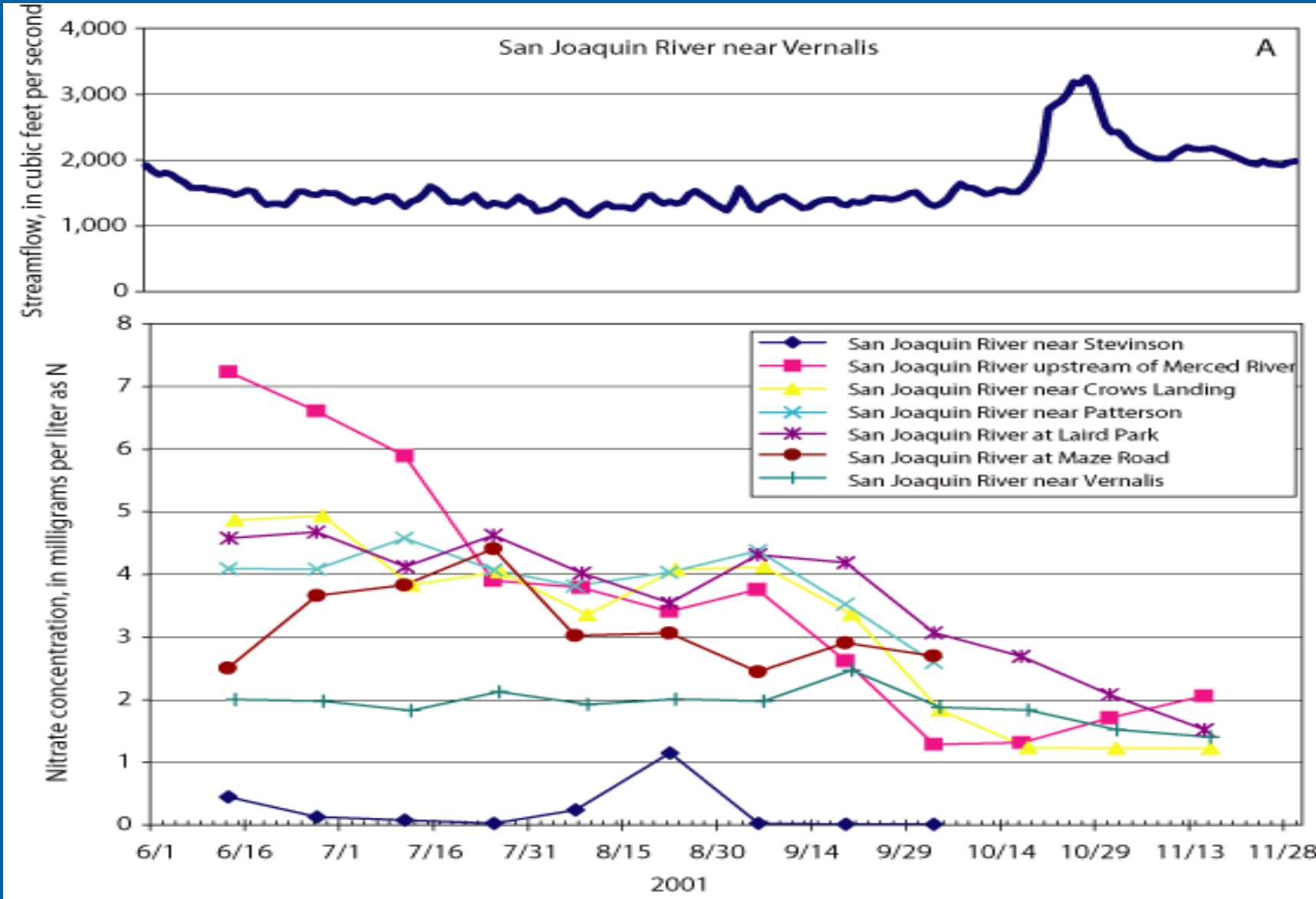
Nitrate Concentrations in SJR, 2001



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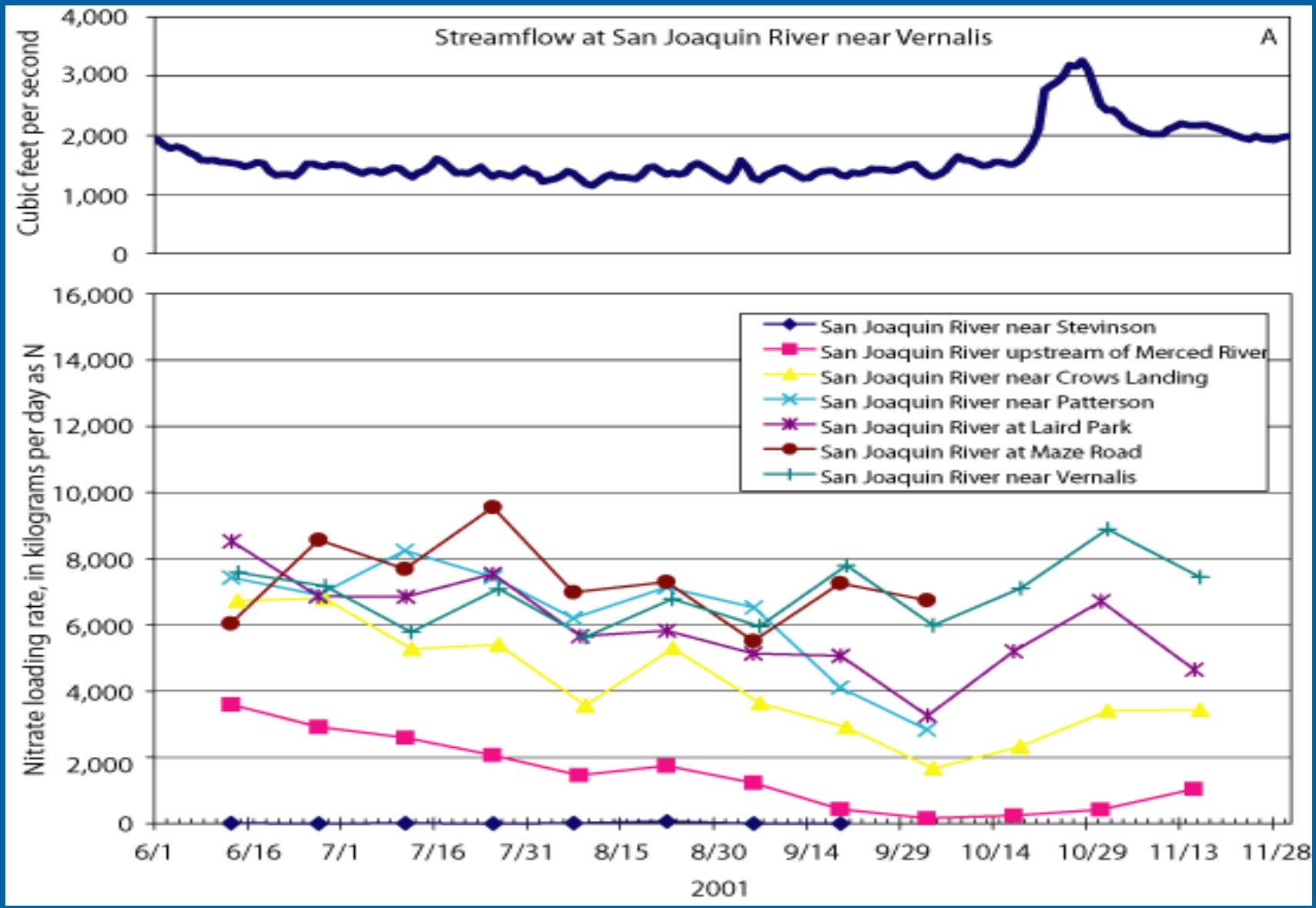
Nitrate Loads in SJR, 2001



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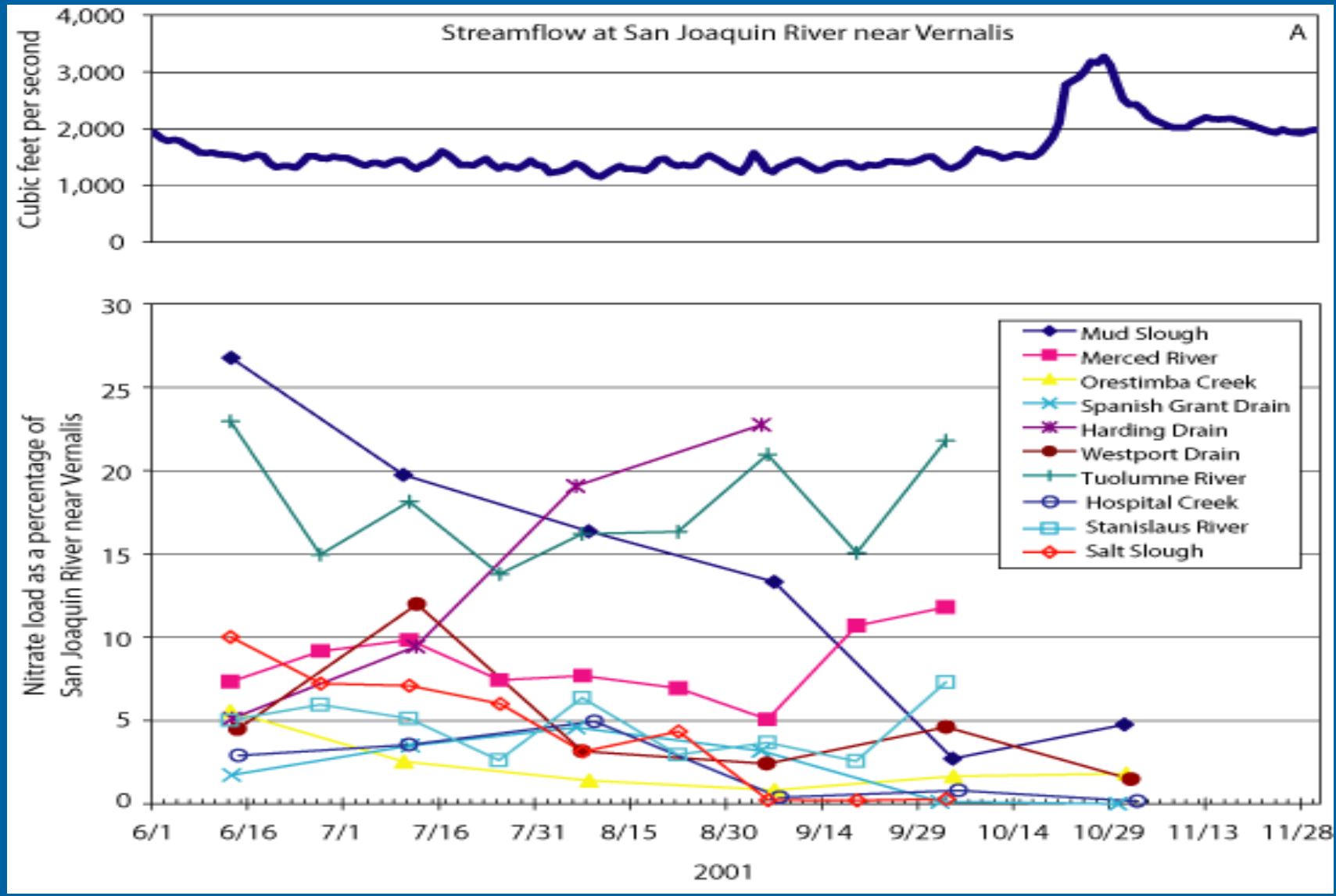
Nitrate Loads in Tributaries, 2001



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Isotopic Analysis of Nitrate Sources, 2000-01

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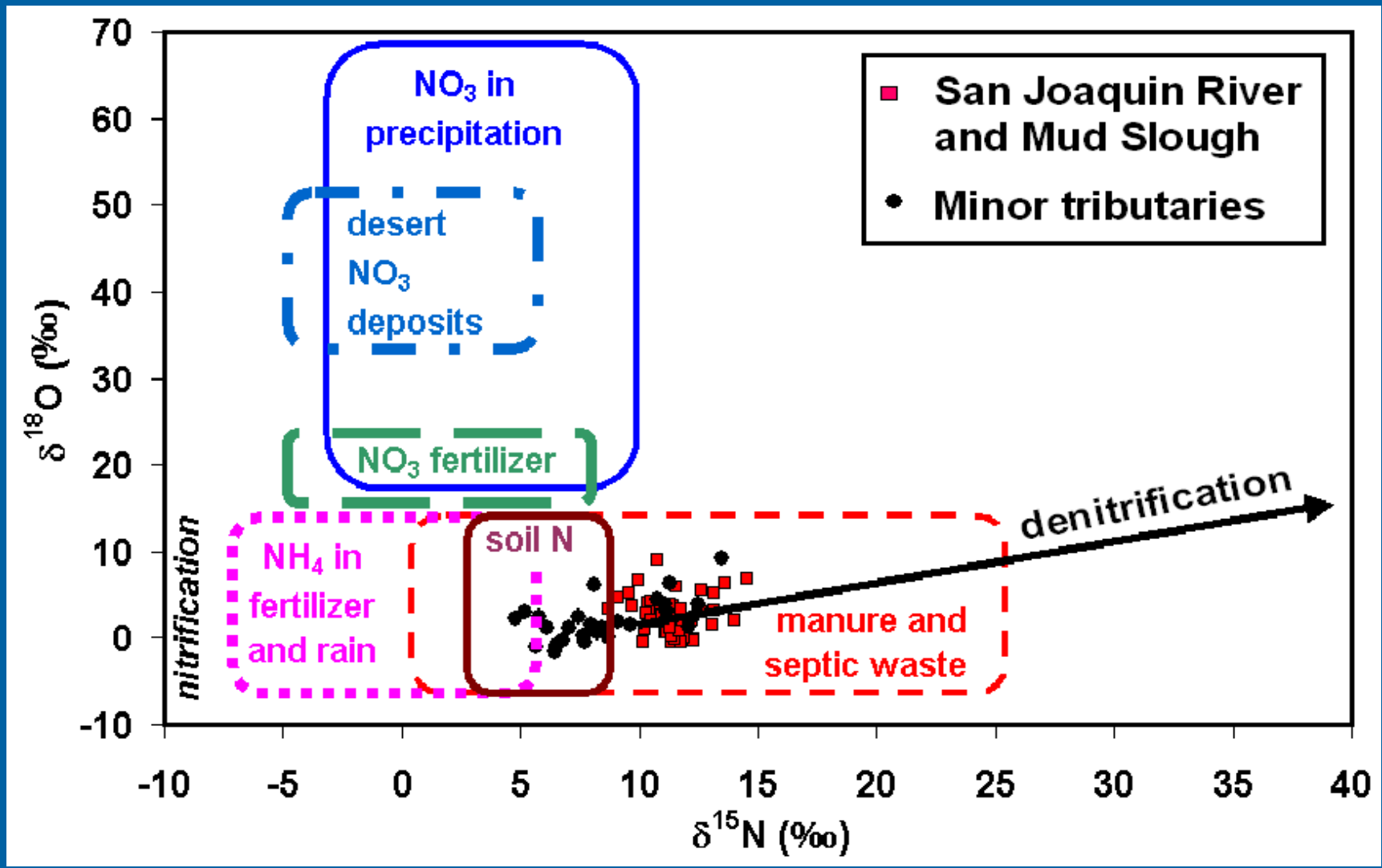
Ranges of 15N and 18O Values of Different Sources of Nitrate



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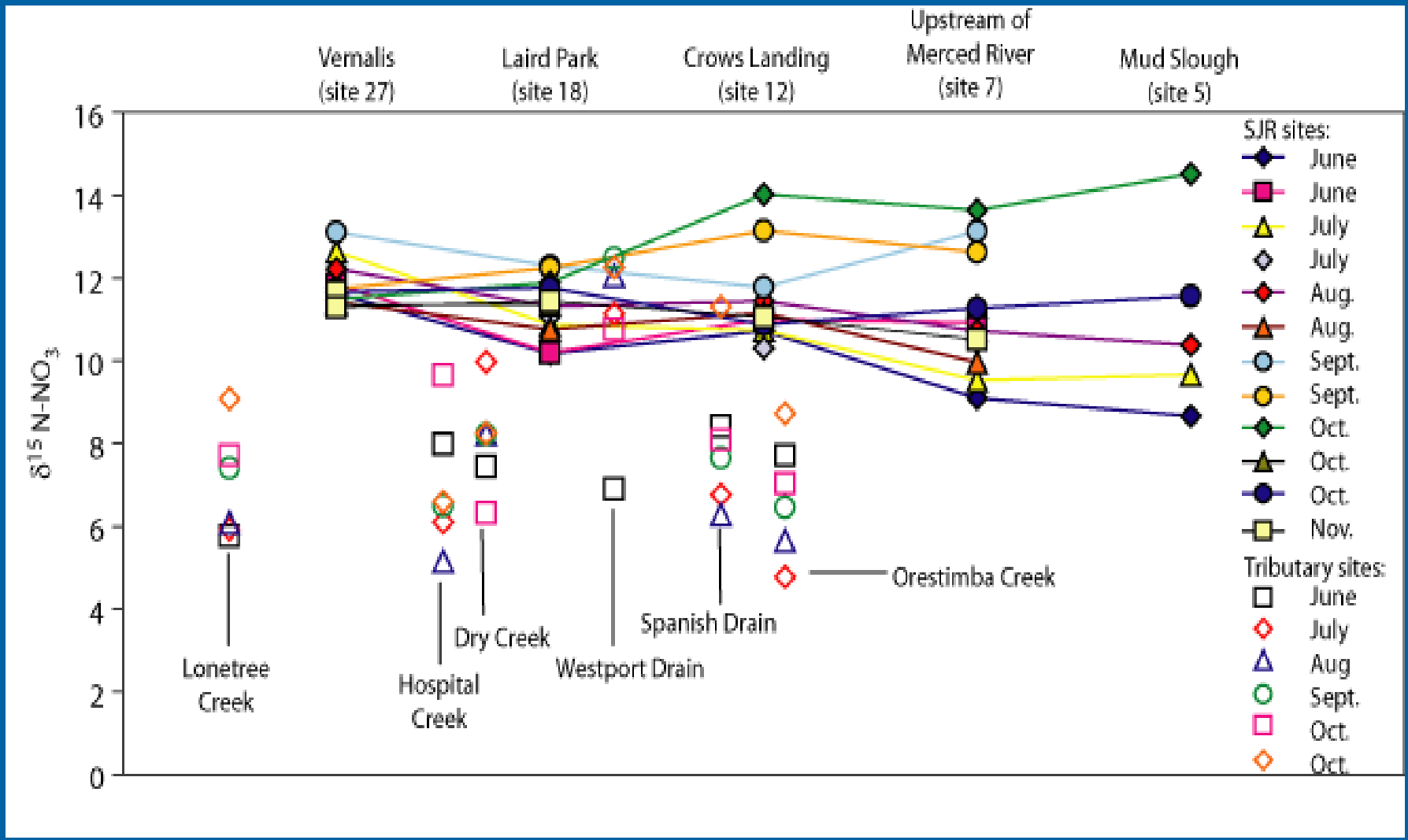
15N Values for SJR and Tributary Samples, 2000-01



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Proposed Study of Nitrate Inputs from Groundwater and their Source

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Three Approaches to Quantifying Nitrate Inputs from Groundwater and their Sources

(1) Boat recon with continuous measurement of temp, EC, and optical properties of water just above streambed. Collect samples and analyze for C, N, and O isotopes and other tracers – compare with samples from source areas.

(2) Nested monitoring wells on banks (3) and in SJR (6). Two years of continuous temp and water level and monthly nutrients. GW inflow rates will be based on 2 numerical methods: simulation of vertical flow and heat flux beneath the streambed at 6 sites; and simulation of 2-D GW flow at the 3 existing transects.

(3) NAWQA-style recon at 30 sites between the 6 monitoring-well sites twice per year (in Spring and Fall, coordinated with the boat recons). At each site -- measure gradients using a manometer with a drivepoint; measure temp differences between river and below streambed; measure nitrate in the river and below the streambed.

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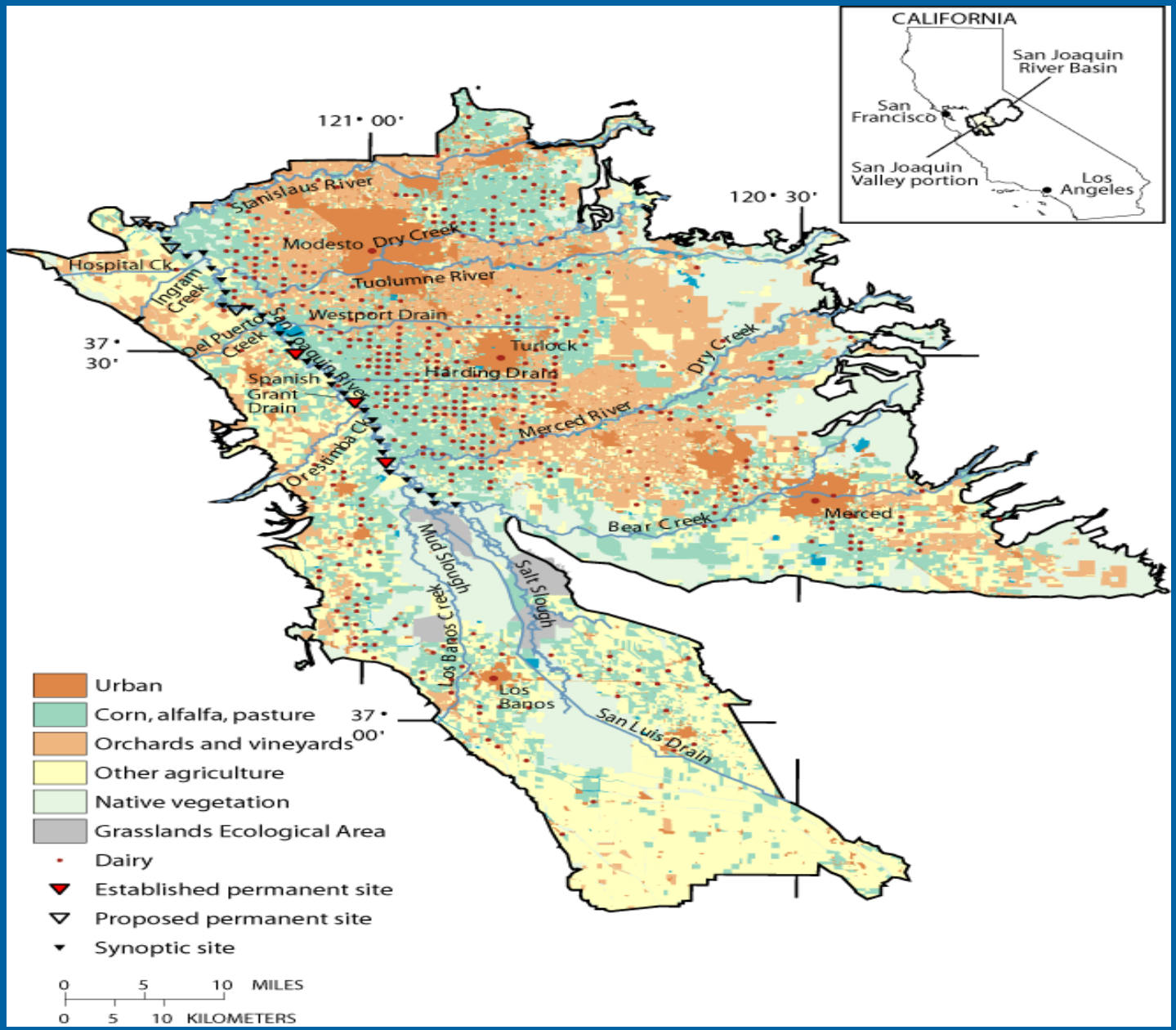
Study Area for Proposed Study



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NAWQA-style Reconnaissance on Merced R

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Conclusions

- No flow-adjusted trend in total nitrogen and total phosphorus concentrations
- Increasing flow-adjusted trend in nitrate concentrations
- Source of increasing nitrate trend: tile drainage and fertilizer application until 1980s; dairies via groundwater inputs presently?

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